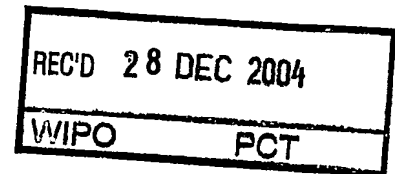


PCT/NZ2004/000306



## CERTIFICATE

This certificate is issued in support of an application for Patent registration in a country outside New Zealand pursuant to the Patents Act 1953 and the Regulations thereunder.

I hereby certify that annexed is a true copy of the Provisional Specification as filed on 26 November 2003 with an application for Letters Patent number 529777 made by Graydon Aubrey Shepherd.

Dated 13 December 2004.

**PRIORITY DOCUMENT**  
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RULE 17.1(a) OR (b)

A handwritten signature in cursive script that reads "Neville Harris".

Neville Harris  
Commissioner of Patents, Trade Marks and Designs



Patents Form # 4



**NEW ZEALAND**

**Patents Act 1953**

**PROVISIONAL SPECIFICATION**

**Title:** Reciprocating Engine

I, *Shepherd, Graydon Aubrey*,

Nationality: *A New Zealand citizen*

Address: *3 Sandringham Road, Mt Albert, Auckland, New Zealand*

do hereby declare this invention to be described in the following statement :

## ***Reciprocating Engine***

### **FIELD OF THE INVENTION**

This invention relates to a reciprocating engine, and in particular, but not exclusively to a reciprocating engine using diesel or petroleum as a fuel source.

### **5 BACKGROUND**

Since the industrial revolution a number of reciprocating engines have been developed, each one having advantages or improvements over previous models.

The fossil fuel reciprocating engines have largely used a two or a four stroke cycle. The two stroke cycle engines having the advantage of one power stroke per revolution, as opposed to  
10 one power stroke for every two revolutions in the four stroke cycle. However, the two stroke cycle engines have two distinct disadvantages. The first being that their breathing is not always efficient, some unburnt fuel and/or oxygen is lost to the exhaust system, and some exhaust gases remain after the exhaust cycle. And secondly, two stroke engines require oil to be added to the fuel to effect lubrication of the crank shaft and piston. Both of these  
15 factors mean that two stroke engines produce high levels of pollution.

A further problem with present technology engines is the conversion of forces felt by the piston into rotary motion. This is traditionally performed using a crank shaft. However, a crankshaft is most efficient when the crank arm is at right angles to the direction of motion of the piston, but is very inefficient at other angles. And the largest forces are felt on the  
20 piston around top dead centre, when the crank arm is almost aligned with the direction of motion of the piston, resulting in very inefficient transfer of forces into the crank arm.

### **OBJECT**

It is therefore an object of the present invention to provide a reciprocating engine which will at least go some way towards overcoming the above mentioned problems, or at least provide  
25 the public with a useful choice.

## STATEMENTS OF THE INVENTION

Accordingly, in a first aspect, the invention may broadly be said to consist in a reciprocating engine operating on the two stroke cycle, comprising;

5 a pair of stationary concentrically aligned mutually opposed pistons separated by a sleeve adapted to reciprocate between the pistons, the reciprocating sleeve defining two cavities, each cavity being operatively connected to one of the pistons to define a chamber, the first chamber being a pre-charge chamber and having at least one valved inlet port, and the second chamber being a combustion chamber and having at least one valved outlet port, the two chambers being separated by a transfer valve.

10 Those skilled in the art will appreciate the advantages of this reciprocating engine. The stationary pistons allow for lubrication of the piston rings by way of internal oil-ways, eliminating the need to add fuel to the oil. Also, the engine design does not require the use of a crank shaft to convert the reciprocating motion into rotary motion. Other arrangements such as a cam roller fitted to the reciprocating sleeve, and a rotating sleeve having a cam  
15 profile can be used.

Preferably the engine uses diesel fuel, but clearly any type of fuel can be used, and a spark plug can be used for ignition.

Preferably the conversion of reciprocating motion to rotary motion is accomplished by the use of a cam roller fitted to the reciprocating sleeve, which is in communication with a  
20 rotating sleeve having a cam profile.

Preferably each of the inlet and outlet ports use their associated piston to effect the opening and closing of the ports. However, other valve arrangements can be used, for example a cam shaft operated valve to provide more flexibility of valve timing.

## DESCRIPTION

25 The invention may also broadly be said to consist in the parts, elements and features referred to or indicated in the specification of the application, individually or collectively, and any or all combinations of any two or more of the parts, elements or features, and where specific

integers are mentioned herein which have known equivalents, such equivalents are incorporated herein as if they were individually set forth.

Two preferred forms of the invention will now be described, by way of example only, with reference to the accompanying drawings in which,

- 5     **FIGURE 1** is a schematic diagram showing the operation of the reciprocating engine cycle with the combustion chamber in the compression phase,

**FIGURE 2** is a schematic diagram showing the operation of the reciprocating engine cycle with the combustion chamber continuing in the compression phase, and air beginning to enter the pre-charge chamber,

- 10    **FIGURE 3** is a schematic diagram showing the operation of the reciprocating engine cycle at the stage where fuel is introduced and ignition occurs, and the power stroke begins,

**FIGURE 4** is a schematic diagram showing the operation of the reciprocating engine cycle towards the end of the power stroke and when the exhaust gases begin to exit the combustion chamber,

- 15    **FIGURE 5** is a schematic diagram showing the operation of the reciprocating engine cycle at the point at which the inlet valve opens to allow a charge of fresh air to transfer from the pre-charge chamber to the combustion chamber, and to complete the purging of the exhaust gases,

- 20    **FIGURE 6** is a schematic diagram showing the operation of the reciprocating engine cycle at the stage where the inlet valve closes and the reciprocating sleeve changes direction to begin the compression stroke,

**FIGURE 7** is a schematic diagram of the reciprocating engine showing the conversion of the reciprocating motion of the reciprocating sleeve into rotary motion using a crank shaft, and

- 25    **FIGURE 8** is a schematic diagram of the reciprocating engine showing the conversion of the reciprocating motion of the cylinder sleeve into rotary motion using a roller which causes a sleeve having a cam profile to rotate.

With reference to **Figure 1**, a reciprocating engine (10) is manufactured comprising at least a reciprocating sleeve (11), a first piston (13) and a second piston (15). The reciprocating sleeve (11) comprises two cylindrical portions, each of which can have a different diameter as shown, and these two cylindrical portions are separated by an intermediate bulkhead (16).

- 5 The reciprocating sleeve (11) is shown moving in a compression stroke direction (17), and is causing the gases in a combustion chamber (19) to be compressed. A partial vacuum is being created in a pre-charge chamber (21).

10 A transfer valve (23) is used to control the flow of gases through a passage (24) in the intermediate bulkhead (16). The transfer valve (23) is a one way valve, and while not shown, is biased closed by a light spring. At the stage of the operating cycle of the engine (10) shown, the transfer valve (23) is closed.

The figures 2 to 6 continue from figure 1 to show one complete cycle of the reciprocating engine (10).

- 15 With reference to **Figure 2**, the engine (10) is shown with the reciprocating sleeve (11) continuing to move in the compression stroke direction (17). The gases in the combustion chamber (19) are continuing to be compressed. At this stage, an inlet port (25) is no longer covered by the second piston (15) and air is able to be drawn in a direction (27) into the pre-charge chamber (21).

- 20 With reference to **Figure 3**, the engine (10) is shown with the reciprocating sleeve (11) reaching the extent of it's travel in the compression stroke direction (17), and beginning to move in the opposite direction, represented as a power stroke direction (29). At this point the gases in the combustion chamber (19) are fully compressed. Diesel fuel (31) is injected into the combustion chamber (19) and self ignites due to the pressure within the cylinder. The burning fuel and compressed gases expand to push against the intermediate bulkhead  
25 (16) and to move the reciprocating sleeve (11) in the power stroke direction (29).

With reference to **Figure 4**, the engine (10) is shown with the reciprocating sleeve (11) moving in the power stroke direction (29) and completing the power stroke. The gases in the combustion chamber (19) are completing their combustion and expansion. The exhaust port

(35) is no longer fully covered by the first piston (13), and is allowing the burnt or exhaust gases to escape in a direction (37).

The pre-charge gases in the pre-charge chamber (21) are being compressed, the inlet port (25) now being covered by the second piston (15).

- 5 With reference to **Figure 5**, the engine (10) is shown with the reciprocating sleeve (11) having moved a little further in the power stroke direction (29). At this stage a significant proportion of the burnt gases have left the combustion chamber (19). The pressure within the pre-charge chamber (21) is now greater than the pressure within the combustion chamber (19), causing the transfer valve (23) to move in a direction (39) and to open the passage (24).
- 10 This allows the compressed gases in the pre-charge chamber (21) to move in a direction (41) and to begin purging the combustion chamber (19).

It can be an advantage to have the diameter of the pre-charge chamber (21) greater than that of the combustion chamber (19) as this gives the opportunity to provide improved purging of the combustion chamber (19).

- 15 With reference to **Figure 6**, the engine (10) is shown with the reciprocating sleeve (11) reaching the full extent of it's movement in the power stroke direction (29), and beginning to move again in the compression stroke direction (17). When the gases have largely transferred out of the pre-charge chamber (21) and into the combustion chamber (19), the transfer valve (23) will move in a direction (41) to close.
- 20 The cycle then continues as described above with reference to figure 1, and so on.

With reference to **Figure 7**, a more complete example of the reciprocating engine (10) is shown. In this example the reciprocating sleeve (11) is shown connected via a short pin (43) to a connecting rod (45) which is in turn connected to a crank shaft (47). The crankshaft (47) is supported on bearings (49), and has a flywheel (51) mounted on it.

- 25 The reciprocating motion (53) is converted into rotary motion (55). Some of the energy transferred into the flywheel (51) during the power stroke is used in turn to move the reciprocating sleeve (11) during the compression stroke, allowing the cycles of the engine to

be continued. Clearly the crankshaft (47) could also include an output shaft or a drive surface.

With reference to **Figure 8**, another example of a more complete reciprocating engine is shown. In this case the crank shaft is replaced by a rotating sleeve (57), having a cam profile (59) on one end. A roller (61) is supported on a pin (63) which is attached to the reciprocating sleeve (11). As the reciprocating sleeve (11) moves in the power stroke direction (17), the roller (61) causes the rotating sleeve (57) to rotate, as the roller (61) acts against the cam profile (59).

As the rotating sleeve (57) rotates, energy is transferred into a flywheel (65). Stored energy within the flywheel (65) causes the rotating sleeve (57) to continue to rotate and in turn the continuation of the cam profile (67) moves the roller (61) in the direction opposite to the direction (17). This action causes the reciprocating sleeve (11) to move in the compression stroke direction (29). The configuration as shown in this figure has the advantage that it has two power strokes per revolution of the rotating sleeve (57). Different cam profiles having more than 2 lobes can be used to provide more than two power strokes per revolution.

In this example the rotating sleeve (57) is mounted on a set of bearings (69). Clearly the rotating sleeve (57) could also include an output shaft or a drive surface.

In both figures 7 and 8 the first and second pistons (13) and (15) and the bearings (49) and (69) are shown as being fixed relative to one another, by the use of a symbol (71) as illustrated in these figures.

## VARIATIONS

While the engine in the examples uses diesel fuel, other fuels such as any hydrocarbon fuel or hydrogen could be used, and an ignition plug could be added to the crown of the first piston to provide ignition if required.

The examples describe an engine having a single reciprocating sleeve and two pistons, but clearly any number of piston and sleeve assemblies can be incorporated into a single engine assembly. Having two engine units as described herein, mounted to act opposing each other



could have the advantage of reducing or balancing out the vibration caused by the reciprocating masses.

## DEFINITIONS

Throughout this specification the word "comprise" and variations of that word, such as  
5 "comprises" and "comprising", are not intended to exclude other additives, components, integers or steps.

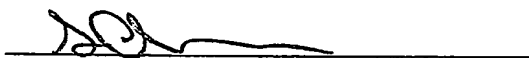
## ADVANTAGES

Thus it can be seen that at least the preferred form of the invention provides a reciprocating engine which operates with a two stroke cycle, but does not require oil to be mixed in with  
10 the fuel for engine lubrication.

Also, the reciprocating engine has improved breathing over traditional two stroke engines, and more efficient purging of the exhaust gases can be achieved.

And, in addition, the method by which the reciprocating motion is converted into rotary motion, by the use of a rotating sleeve having a cam profile on one end, allows greater  
15 flexibility in the way in which power is extracted during the power stroke. That is, the cam profile can be optimised so that the forces produced by the sleeve during the power stroke can be most efficiently turned into rotary motion. The conversion of reciprocating motion into rotary motion is no longer constrained by mechanical linkage to the circular motion of a crank shaft.

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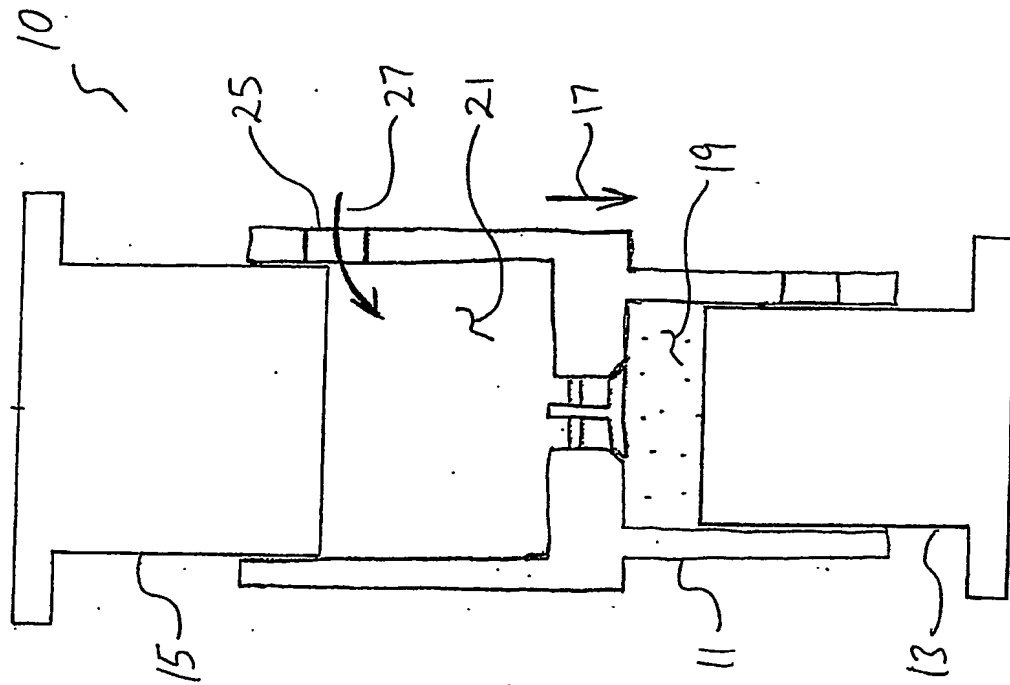
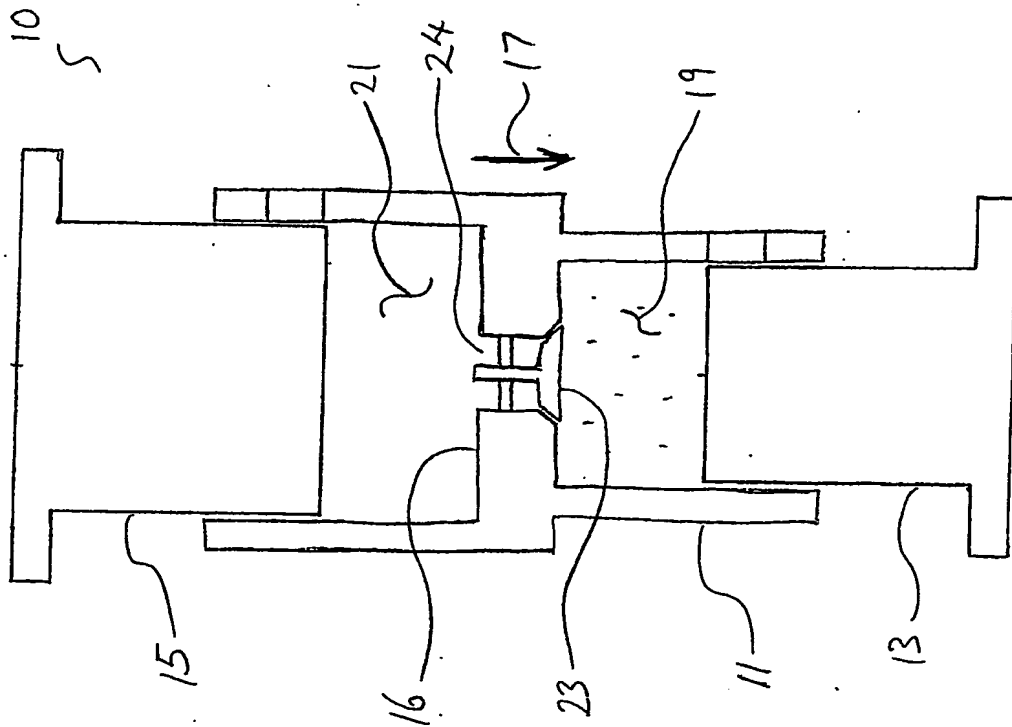


**PIPERS**

**Attorneys for:**

25 *Graydon Aubrey Shepherd*





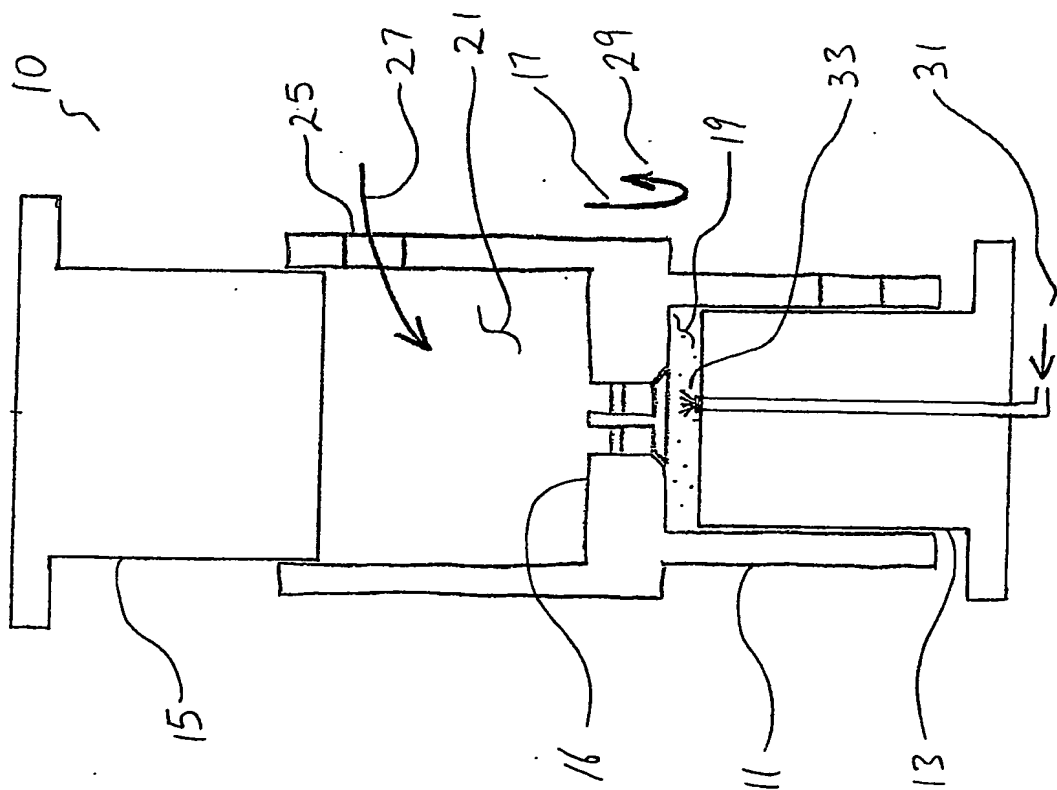


FIG 3

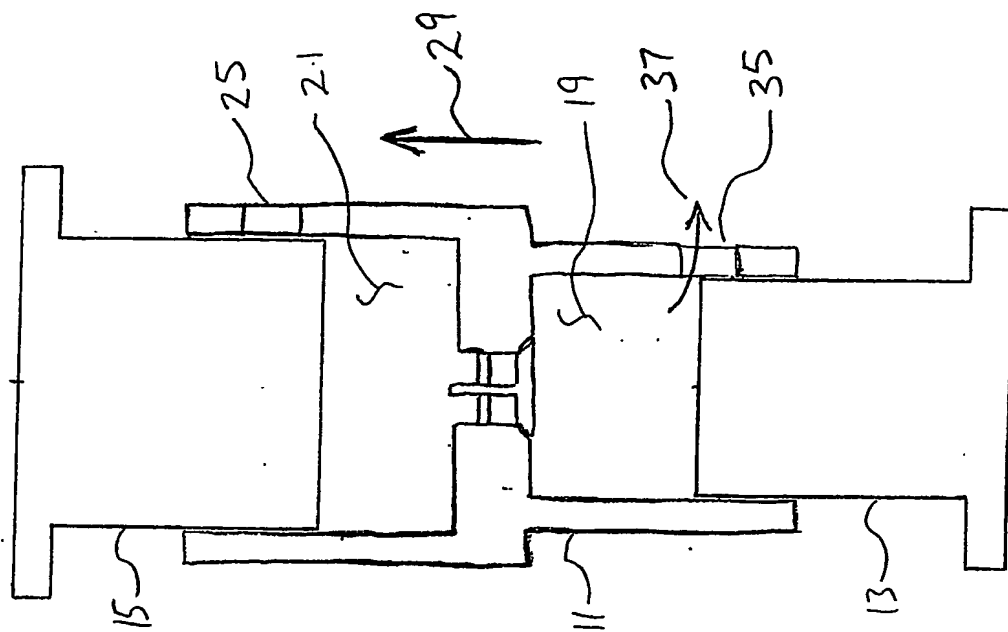
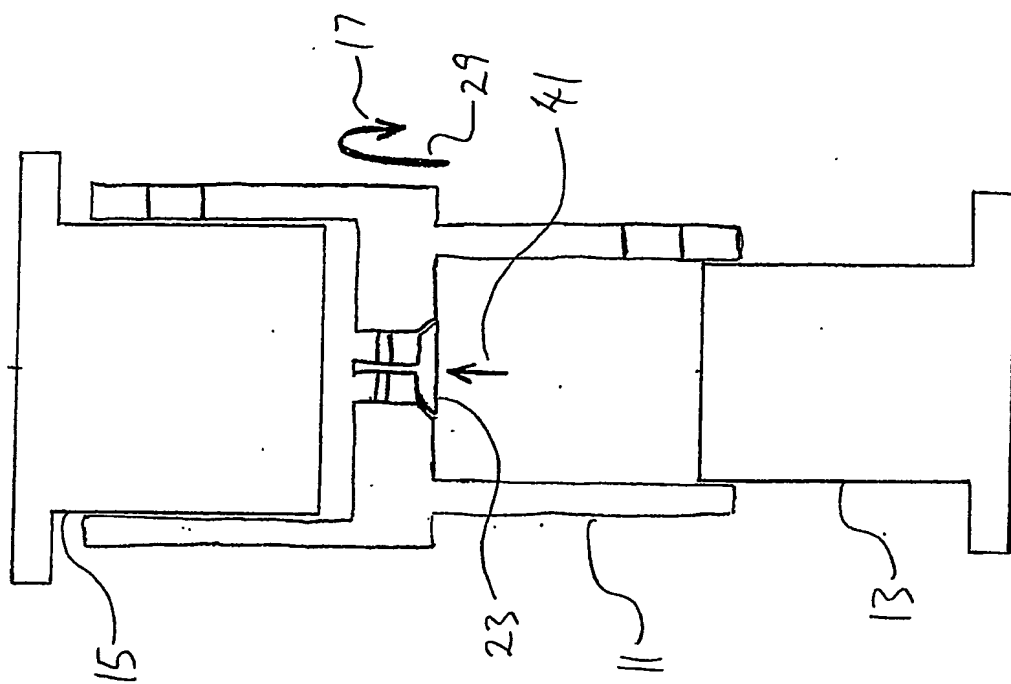
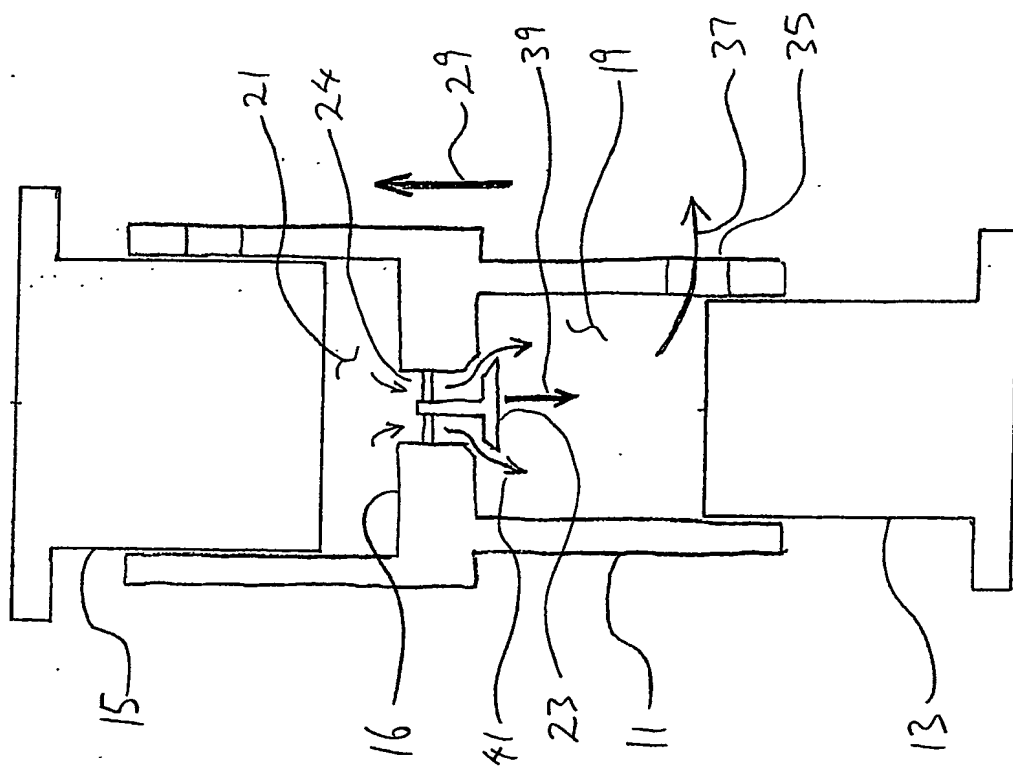


FIG 4



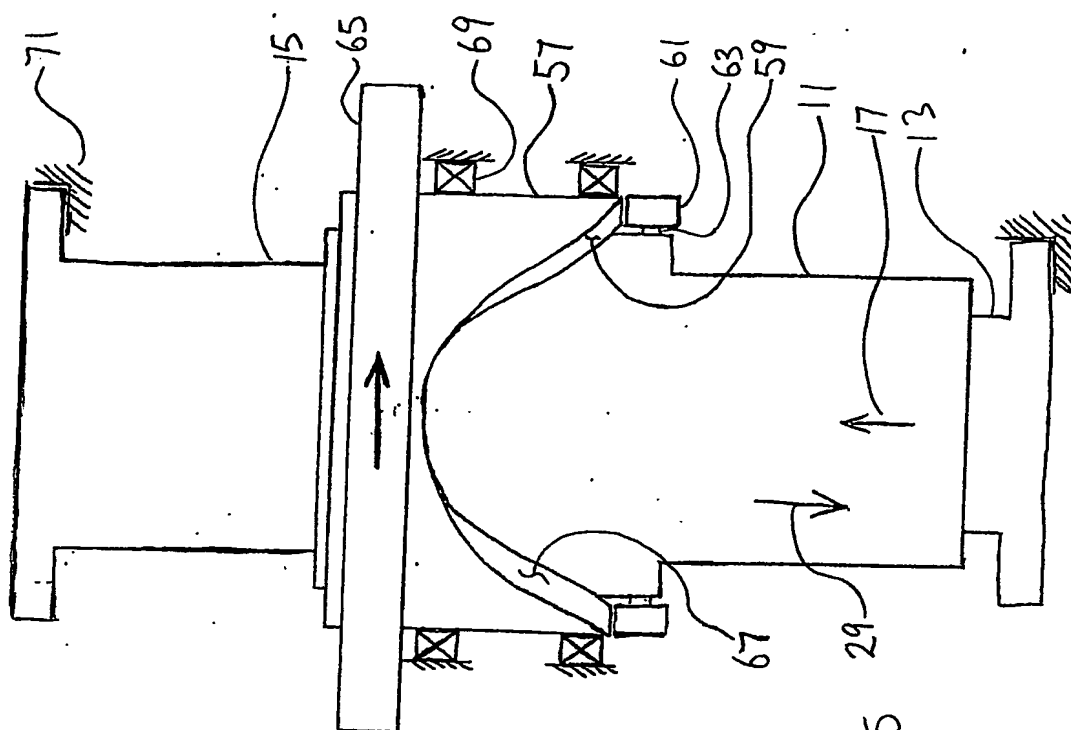


FIG 8

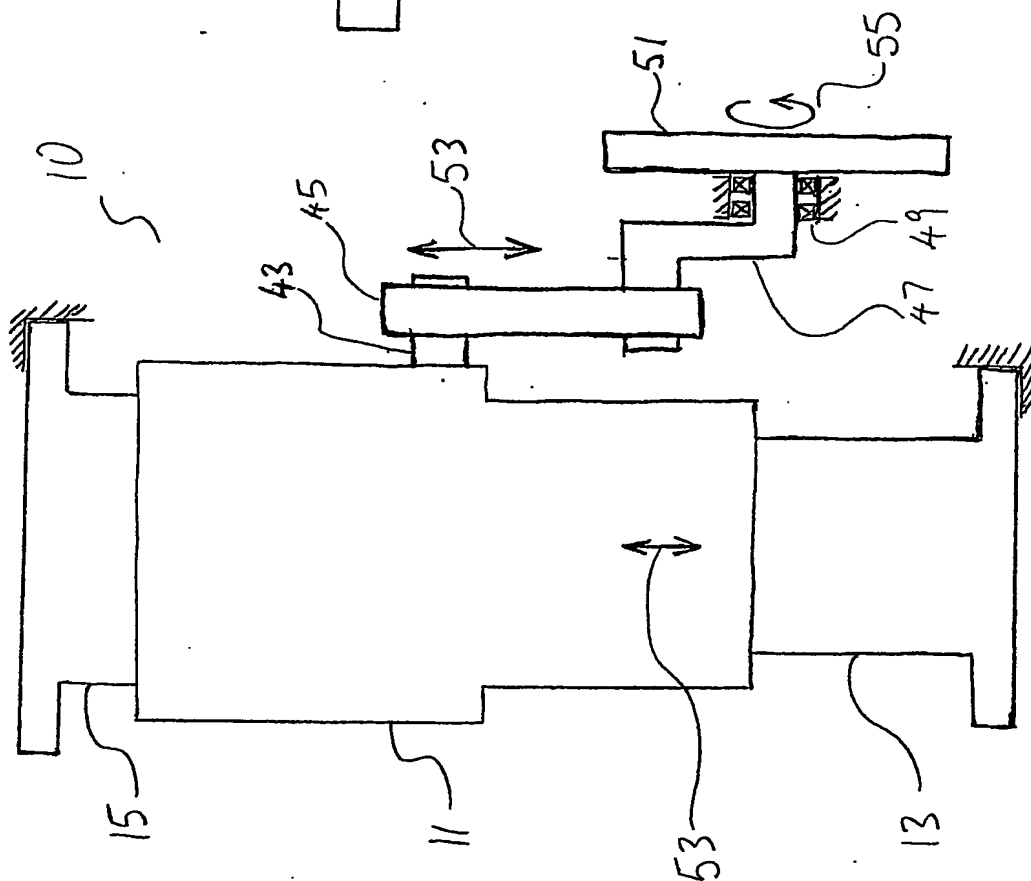


FIG 7.